

## **SUPPLEMENTAL MATERIAL**

### **Secondary Issues Discussed at the Summit**

#### Metabolites

The fate of only a subset of parent pharmaceutical chemicals have been studied. They all produce metabolites and other degradation products which could have equal or greater toxicity than the parent compound (Farré et al. 2008; Isidori et al. 2005; Nalecz-Jawecki 2007) and some of these metabolites have been shown to be ubiquitous in the environment (Farré et al. 2008). The major challenge in this respect is that without knowing the identity of these degradation products, fundamental laboratory studies need to be undertaken to determine their chemical nature and biological activity. This would be a major undertaking but could be eased, somewhat, by a dialog and collaboration between environmental researchers and drug manufacturers.

## Tables

Table 1. Top Best Management Practices (BMPs) for the four spheres considered.

<b>Industrial sphere.</b> <ul style="list-style-type: none"><li>• Establish a “Return Product” program</li><li>• Develop new packaging with specifics on unused drug disposal</li><li>• Re-evaluate sample/marketing practices</li><li>• Examine and possibly change the process for determining expiration dates</li></ul>
<b>Medical and Veterinary sphere</b> <ul style="list-style-type: none"><li>• Educate doctors and veterinarians</li><li>• Pharmacists to indicate proper disposal methods on prescriptions</li><li>• Reduce drain disposal at all medical facilities</li><li>• Only prescribe what is needed</li></ul>
<b>Social and Agricultural sphere</b> <ul style="list-style-type: none"><li>• Educate alternatives to disposal and prophylactic use</li><li>• Educate public against using drain disposal for unused drugs</li><li>• Education on environmental impacts</li><li>• School programs</li><li>• Increase use of technology to provide patient education (e-mails, websites, blogs)</li></ul>
<b>Environmental sphere</b> <ul style="list-style-type: none"><li>• Identify BMPs already in place</li><li>• Evaluate current treatment technologies</li><li>• Initiate funding for increased monitoring</li><li>• Develop public relations campaign</li><li>• Include pharmaceuticals in other water pollution programs</li></ul>

Table 2. Recommendations for better communication and education

<b>High priority</b>	<ul style="list-style-type: none"><li>• Need for a public policy discussion</li><li>• Need for a brief written response to the question, “Is my water safe?” (see the example given by the Collaborative)</li></ul>
<b>Medium priority</b>	<ul style="list-style-type: none"><li>• Use science-based, best practice communication</li><li>• Add communication experts to those consolidating research findings</li><li>• Promote existing trusted web sites</li></ul>
<b>Lower priority</b>	<ul style="list-style-type: none"><li>• Foster dialog within the scientific community</li><li>• Foster dialog with the media</li><li>• Develop a trusted website</li></ul>

Table 3. Summary of research needs and recommendations evolved during the Summit

<p><b>Sources of Pollution, Fate and Transport</b></p> <ul style="list-style-type: none"> <li>• More <b>scientific data</b> regarding the source, fate, and transport of pharmaceuticals in the aquatic environment and their impact on human health</li> <li>• Better and more representative sampling <b>methods</b> that take into account both, spatial and temporal variability to produce more comprehensive occurrence data</li> <li>• Better access to <b>physico-chemical data</b> of the chemicals from the manufacturers</li> <li>• Study of <b>bioconcentration</b> of pharmaceuticals for a better assessment of their environmental impact</li> <li>• <b>Prioritization</b> of pharmaceuticals based on their environmental risk</li> <li>• Identification of both human and environmental Transformation Products</li> <li>• Evaluation of <b>waste water treatment</b> and water reuse technologies towards removing or reducing levels of pharmaceutically active chemicals</li> </ul>
<p><b>Exposure Effects and Risks to Humans and Ecosystems</b></p> <ul style="list-style-type: none"> <li>• Increase information on environmental and human <b>impact of pharmaceutically active chemicals</b></li> <li>• Assessment of environmental risk posed by <b>long-term and low-dose exposure</b> of pharmaceuticals and <b>mixtures</b> of chemicals</li> <li>• Use of epidemiological/biomonitoring/demographics approaches for risk assessment</li> <li>• Consideration of <b>non traditional endpoints</b> of toxicity such as behavioral, developmental, and reproductive responses including the use of “omics” techniques</li> <li>• Study of <b>ecosystem adaptation</b> and the changes in sensitivity of organisms with continuous exposure to target chemicals</li> <li>• Consideration of <b>sensitive sub-populations or life stages</b> of aquatic species/organisms</li> <li>• Development of sensitive biosensors to measure the presence of pharmaceutically active chemicals in the aquatic environment</li> <li>• <b>Prediction tools</b> for the long-term effects of pharmaceutical residues in the environment and on human health.</li> </ul>
<p><b>Best Management Practices (BMPs)</b></p> <ul style="list-style-type: none"> <li>• <b>Prevention of environmental and human health effects</b> from predictions based on occurrence and health effects research</li> <li>• Consideration of <b>different spheres for the implementation of BMPs:</b> industrial, medical/veterinary, social/agricultural and environmental</li> <li>• <b>Education programs</b> for the health care community and general public on the <b>proper disposal</b> of unused medicine.</li> <li>• Better interagency cooperation, data sharing, and federal facilitation</li> <li>• Funding initiation to <b>increase monitoring</b> and to include pharmaceuticals in</li> </ul>

water pollution programs. • Evaluation of the effectiveness of BMPs after their implementation • <b>Responsible individual</b> or institution to oversee the broader issue of “pharmaceuticals in drinking water”
<b>Education and Communication</b>
• Use of <b>new technologies</b> for facilitating communication and collaboration. • Identification of the <b>target audience</b> • Need for a <b>public policy discussion</b> • Communication of <b>clear information</b> about water safety to the public.

### Citations

Farré Ml, Pérez S, Kantiani L, Barceló D. 2008. Fate and toxicity of emerging pollutants, their metabolites and transformation products in the aquatic environment. *TrAC Trends in Analytical Chemistry* 27(11): 991-1007.

Isidori M, Lavorgna M, Nardelli A, Parrella A, Previtera L, Rubino M. 2005. Ecotoxicity of naproxen and its phototransformation products. *Science of The Total Environment* 348(1-3): 93-101.

Nalecz-Jawecki G. 2007. Evaluation of the in vitro biotransformation of fluoxetine with HPLC, mass spectrometry and ecotoxicological tests. *Chemosphere* 70(1): 29-35.